MODULE CONTENT

| Unit of Competency | **DIAGNOSE AND REPAIR STEERING SYSTEM** |
| --- | --- |
| Module Title | **DIAGNOSING AND REPAIRING STEERING SYSTEM** |
| Module Descriptor | This unit identifies the competence required to diagnose and repair the steering systems. |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose and repair steering system | |
| LO2. Diagnose steering system | |
| LO3. Repair steering system | |
| LO4. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 3**

**REPAIR STEERING SYSTEM**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Repair steering system | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Repair steering system | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Repair steering system | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Repair steering system | Remember the step-by-step procedure the Repair steering system |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**REPAIR STEERING SYSTEM**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Made final inspection.
2. Turned-over vehicle.
3. Restored work area.
4. Managed wastes.
5. Checked and stored tools and equipment.
6. Accomplished workplace documents.

**PROCEDURE**

**Rack and Pinion Steering Inspection**

STEP 1 *Check all working component* ***(Figure44 – 33)*** *of the system. Inspects the flexible steering coupling or the universal joints for wear or looseness. If any play is found, recommend replacements. Universal joints can also seize or bind. They should be checked closely.*

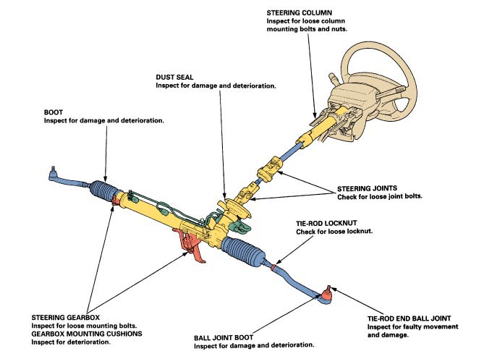
STEP 2 *Grasp the pinion gear shaft at the flexible steering coupling and try to move it in and out the gear. If there is movement, the pinion bearing preload might need adjustment. If there is no adjustment, internal components have to be replaced.*

STEPS 3 *Carefully inspect the rack housing. In most cases, the rack and pinion steering assemblies, the rack and pinion steering are mounted in rubber bushings. As the vehicle gets older, these mounting bushings deteriorate from the heat, age, and oil leakage from the engine. When this happens, the housing moves within its mountings and causes loose and eratic steering can be caused by a bent rack assembly, tight yoke bearing adjustment, loose power-steering belt, weak pump, internal leaks in power-steering belt, weak pump,, internal leaks in power-steering system, and damaged CV Joints from-wheel-drive vehicles.*

STEP 4 *Check the inner tie-rod socket assemblies located inside the bellows. The most foolproof way of checking these sockets is to loosen the inner bellows clamp and bellows boot until the inner tie-rod socket can also be checked by squeezing the bellows boot until the inner socket can be felt. Push and pull on the tire. If looseness id found in the tie rod, it should be replaced. On some vehicles the boot might be made of hard plastic. For this type of boot, lock the steering wheel and push and pull on the tire. Watch for in-and-out movement of the tie rod. If movement is observed, replace the inner tie rod.*

*One fact to keep in mind is that the condition of the bellows boots determines the life of the inner socket. The bellows boot protects the rack from contamination. It might also contain fluid that helps keep the rack lubricated. If any cracks, spilt, or leaks exist, the boots should be replaced. Also, be sure that clamps for the bellows are in their proper place and fastened tightly.*

STEP 5 *Inspect the outer tie-rod ends. In addition to the dry park check, grab each end d and rotate to feel for any roughness that would indicate internal rusting. Be sure to check for bent or damaged forgings and studs, split or deteriorated seals, and damaged, out-of-round, or loose tapers. If any of these conditions exist, the parts should be replaced.*

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**Figure 44-33** All steering parts should be carefully checked during diagnosis.

**STEERING SYSTEM SERVICING**

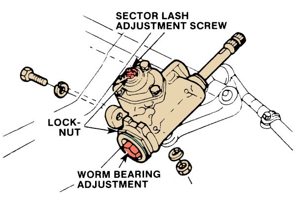
When a steering system component is found to be faulty, it is replaced. Most often part replacement is quite straightforward but you should always refer to the service manual before proceeding. At times, diagnosis will indicate a need to adjust the steering gear or inspect and repair the steering column.

**Steering Gear Adjustments**

Before any adjustments are made or servicing procedures performed to the steering gear, a careful check

should be made of front-end alignment, shock absorbers, wheel balance, and tire pressure for possible steering problems.

Before adjusting or servicing a manual steering gear, the technician must disconnect the battery ground cable. Raise the vehicle with the front wheels in the straight-ahead position. Remove the pitman arm nut. Mark the relationship of the pitman arm puller. Loosen the steering gear adjuster plug lock nut and back the adjuster plug off one-quarter turn **(Figure 44 – 34).** Remove the horn shroud or button cap. Turn the steering wheel gently in one direction until stopped by the gear; then, turn back one-half turn. Measure and record bearing drag by applying a torque wrench with a socket on the steering wheel nut and rotating through a 90-degree arc. Check the service manual for the correct amount drag.



**Figure 44-34** Typical steering gear adjustment.

Once these steps are taken, the steering gear is ready for adjusting or servicing as per instruction in the vehicle’s service manual.

**Steering Manual**

To perform service procedures on the steering column upper and components, it is not necessary to remove the column from the vehicle. The steering wheel, horn components, directional signal switch, ignition switch, and lock cylinder can be removed with the column remaining in the vehicle.

To determine if the energy-absorbing steering column components are functioning as designed, or if repairs are required, a close inspection should be made. An inspection is called for in all cases where damage is evident or whenever the vehicle is being repaired due to a front-end collision. If damage is evident, the affected parts must be replaced. Because of the differences in the steering column styles anf various manual for more explicit inspection and servicing procedures.

| *WARNING!* |
| --- |

| *Set the parking brake before removing the steering column. Also, remove the battery cable from the negative terminal. Remember that special precautions must be observed before beginning disassembly and during assembly to ensure the correct fitting together of the steering column shafts and steering gear shaft connection* |
| --- |

**POWER-STEERING SYSTEM SERVICING**

Vehicles with power-steering system have the same type of steering linkage as manual steering. The power –steering linkage is checked and serviced as previously described. Actually, the only difference is the hydraulic components such as the hoses, pump, and power-steering gear that are fully covered in the vehicle’s service manual. One of the common procedures that is recommended by manufacturers as part of a preventive maintenance program is flushing maintenance program is flushing the hydraulic system

| *WARNING!* |
| --- |

| *Nearly all late-model vehicles are equipped with at least a driver’s side air bag. The air bag module id house in the steering wheel pad that must be removed before the steering wheel can be removed. Plus, it is dangerous to work on or around the steering column without following these precautions:*  *Always wear safety wears glasses when repairing an air bag system or when handling an air bag module.*  *To prevent accidental deployment and possible injury, the backup power supply for the air bag must be depleted before replacing, adjusting, or striking components close to air bag sensors.*  *To deplete backup power supply, disconnect the ground cable of the battery and wait at least one minute (some manufacturers recommend a longer waiting period).*  *Refer to the appropriate service manual to indentify the location of the air bag sensors.*  *Never probe the connectors on the air bag module; this can cause accidentals deployment.*  *Carry a live air bag module with and trim cover pointed away from your body.*  *Never set live air bag module down with the trim cover face down.*  *If a vehicle with an air bag was involved in an accident, inspect its sensor mounting bracket and wiring harness for damage. Replace any damaged parts.*  *After deployment of an air bag, the bag and the surrounding surfaces may contain sodium hydroxide, which is a skin irritant. Wash your hands with soap and water after working around the bag.* |
| --- |

**Flushing the System**

The reason for flushing the system should be obvious. Hydraulic fluid is easily contaminated by moisture and dirt. Flushing removes the old fluid with its contaminants and new fluid is added to the system. It is also wise to flush the system after you have replaced or repaired a part in the system. Before beginning to flush the system, you should disable the engine’s ignition. Then disconnect the power-steering return hose and plug the reservoir. Attach an extensions hose between the power-steering return hose and an empty container. Raise the vehicle’s front wheels off the ground. Fill the reservoir with the correct type fluid

| *WARNING!* |
| --- |

| *Never mix oil types. Any mixture or any unapproved oil can lead to seal deterioration and leaks.* |
| --- |

Turn the steering wheel from stop-to-stop while cranking the engine until the fluid leaving the return hose cranking the engine until the fluid return hose is clean. Never crank the engine for more than 5 seconds at a time. Add fluid to the reservoir to make sure it does not empty. Once the fluid id clear, fill the reservoir to its full mark and lower the vehicle.

Disconnect the extension hose from the power-steering return hose and reconnect the return hose to the reservoir. Check the fluid level again and add fluid as necessary. Now, enable the ignition system. Start the engine and turn the steering wheel from stop-to-stop. If the power –steering system is noisy and bubbles are forming in the fluid, the system must be purged of air.

**FOUR-WHEEL STEERING SYSTEMS**

A few manufacturers have offered four-wheel steering systems in which the rear wheels also help to turn the car by electrical, hydraulic, or mechanical means. Although they are certainly are not very common, you should be aware of how they work

Production-built car tends to understeer. If a car could automatically compensate for an understeer/oversteer problem, the driver would enjoy nearly neutral steering under varying operating conditions. **Four-wheel steering (4WS)** is a serious effort on the part of the automotive design engineer to provide near-neutral steering with the following advantages:

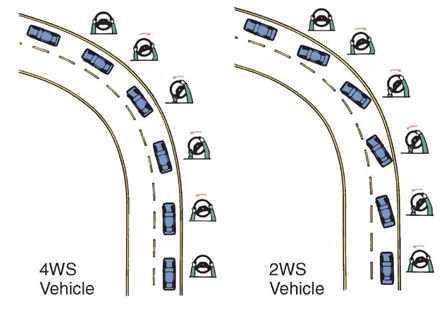
The vehicle’s cornering behavior become more stable and controllable at high speeds asa well as on wet or slippery road surfaces **(Figure 44 – 35).**

The vehicle’s response to the steering input becomes quicker and more precise throughout the vehicle’s entire speed range.

The vehicle’s straight-line stability at high speeds is improved. Negative effects of road irregularities and crosswinds on the vehicle’s stability are minimized.

Stability in lane changing at high speeds is improved. High speed slalom-type operations become easier. The vehicle is likely to go into a spin even situations in which the driver must make and relative large change of direction.

Be steering the rear wheels in the direction opposite the front wheels at low speeds, the vehicle’s turning circle is greatly. Therefore, vehicle maneuvering on narrow roads and during parking becomes easier.



**Figure 44-35** A comparison of 2WS and 4WS vehicle behavior during cornering.

To understand the advantages of four-wheel steering, it is wise to review the dynamics of typical steering maneuver with a conventional front-steered vehicle. The tire is subject to the force of grip, momentum, and steering input when making a movement other than straight-ahead driving. These forces compete with each other during steering maneuvers. With a front-steered vehicle, the rear end is always trying to catch up to the directional changes of the front wheels. This causes the vehicle to sway. As a normal part of operating a vehicle, the driver learns to adjust these forces without thinking about them.

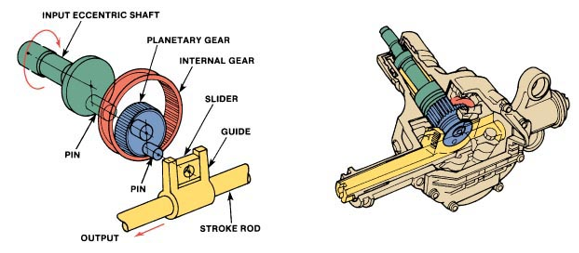
When turning, the driver is putting into motion a complex series of forces. Each of these must be balance against each others. The tires are subjected to road grip and slid angle. Grips hold the car’s wheels to the road, and momentum moves the car straight ahead. Steering input causes the front wheels to turn. The car momentarily resists the turning motion, causing a tire slip angle to form. Once the vehicle begins to respond to the steering input, cornering forces are generated by the front tires. This is referred to as rear-end lag because there is a time delay between the steering input and the vehicle reaction. When the front wheels are turned back to straight –ahead position, the vehicle must again try to adjust by reversing the same forces developed by the turn. As the steering is turned, the vehicle’s body sways as the wheels again try keep up with the cornering forces generated by the front wheels.

The idea behind four-wheel steering id that a vehicle requires less driver input for any steering maneuver if all four-wheels are steering the vehicles. As with two-wheel-steer vehicles, tire grip hold the four wheels on the road. However, when the driver turns the wheel slightly, all four wheels react to the steering input, causing slip angles to form at all four wheels. The entire vehicle moves in one direction rather than the rear half attempting to catch up to the front. There is also less sway when the wheels are turned back to a straight-head position. The vehicle responds more quickly to steering input because rear wheel lag eliminated.

Because each 4WS system is unique in its construction and repair needs, the vehicle’s manual must be followed for proper diagnosis, repair, and alignment of a four-wheel system.

**Mechanical 4WS**

In a straight-mechanical type of 4ws, two steering gears are used - one for the front and other for the rear wheels. A steel shaft connects the two steering gearboxes and terminates at an eccentric shaft that is filled with an offset pin **(Figure 44 – 36)**. This pin engages a second offset pin that fits into a planetary gear.

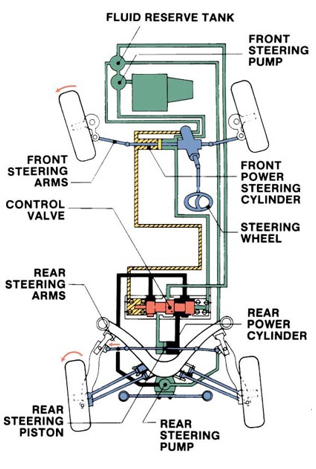


**Figure 44-36** Inside a rear-steering gearbox is a simple planetary gear setup.

A 120-degree turn of the steering wheel rotates the planetary gear to move the slider in the same direction that the front wheels are headed. Proportionately, the rear wheels turn the steering wheel about 1.5 to 10 degrees. Further rotation of the steering wheel, past the 120-degree point, causes the rear wheels to start straightening out due to the double-crank action (two econcentric pins) and rotation of the planetary gear. Turning the steering wheel to a greater angle, about 230 degrees, find the rear wheels in an neutral position regarding the front wheels. Further rotation of the steering wheel results in the rear wheel going counter phase with regard to the front wheels. About 5.3 degrees maximum counter phase rear steering is possible.

**Hydraulic 4WS**

The hydraulic operated 4WS system shown in **Figure 44 – 37** is a simple design, both in components and operation. The rear wheels turn only in the same direction as the front wheels turn only in the same direction as the front wheels. They also turn no more than ½ degrees. The system only activates at a speed above 30 mph (50 km/h) and does not operate when the vehicle moves in reverse.



**Figure 44-37** A simple hydraulic 4WS system

A two-way hydraulic cylinder on the rear stub frame turns the wheels. Fluid for this cylinder is supplied by rear steering pump that is driven by the differential. The pump only operates when the front wheels are turning. A tank in the engine compartment supplies the rear steering pump with fluid.

When the steering wheel id turned, the front steering pump sends fluid under pressure to the rotary valve in the front rack and pinion unit. This forces fluid into the front power cylinder, and the front pressure varies with the turning of the steering wheel. The faster and farther the steering wheel id turned, the greater the fluid pressure.

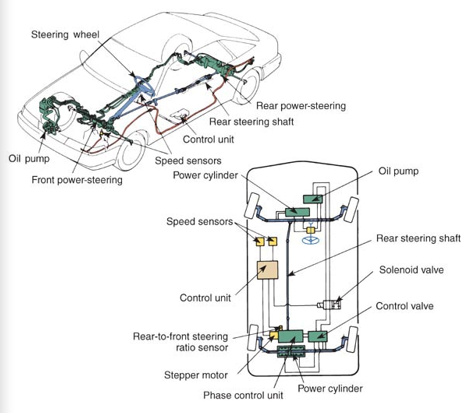
The fluid is also fed under the same pressure to the control valve where it opens as spool valve in the control valve housing. As the spool valve moves through and operate the rear power cylinder. The higher the pressure on the spool, the father it moves. The farther it moves,, the more fluid it allows through to move the rear wheel. As motioned earlier, this system limits rear wheel movement to ½ degrees in either the left and right direction.

**Electro/Hydraulic 4WS**

Several 4WS systems combine computer electronic controls with hydraulic to make the system sensitive to both steering speed. In this designs, a speed sensor and steering wheel angle sensor feed information to the electronic control unit (ECU). By processing the information received, the ECU commands the hydraulic system are not considered a dynamic factor in the steering process.

At moderate road speeds, the rear are steered momentarily counterphase, through neutral, then in phase with the front wheels. At high road speeds, the rear wheels turn only in phase with the front wheels. The ECU must know not only road speed, but also how quickly the steering wheel is turned. These three factors – road speed, amount of steering wheel turn, and the quickly the steering wheel is turn – are interpreted by the ECU to maintain continuous and desired steering of the rear wheels.

Another electro/hydraulic 4WS system is shown in **Figure 44 – 38.** The basic working elements of the design are the control unit, a stepper motor, a swing arm, a set of beveled gears, a control rod, and a control valve with an output rod. Two electronic sensors tell the ECU how fast the car is going.



**Figure 44-38** An electronically and hydraulically controlled 4WS system using a stepper motor and control yoke.

The yoke is a major mechanical component of this electro/hydraulic design. The position of the control yoke varies with vehicle road speed. For example, at speeds below 33 mph (53 km/h), the control yoke swing up through a neutral position, the rear wheels steer in phase with the front wheels.

The steeper motor moves the control yoke. A swing arm is attached to the control yoke. The position of the yoke determines the arc of the swing rod. The arc of the swing arm is transmitted through a control arm that passes through a large bevel gear. Steeper motor action eventually causes a push-or-pull movement of its output shaft to steer the rear wheel up to a maximum of 5 degrees in either direction.

The electronically 4WS system regulates the angle and direction of the rear wheels in response to speed and driver’s steering. The speed-sensing system optimizes the vehicle’s dynamic characteristics at any speed, thereby producing enhanced stability and, within certain parameters, agility.

The actual 4WS system consists of a rack and pinion front steering that is hydraulically powered by a main twin-tandem pump. The system also has a rear-steering mechanism, hydraulically powered by the main pump. The rear-steering-shaft extends the rack bar of the front-steering assembly to the rear-steering phase control unit.

The rear steering is comprised of the input end of the rear-steering shaft, vehicle speed sensors, and steering-phase control unit (deciding direction and degree), a spring is incorporated that locks the rear system in a neutral (straight-ahead) position in the event of the hydraulic failure. Additionally, a solenoid valve that disengages the hydraulic boost (thereby activating the center lock spring in case of an electrical failure) is included.

All 4WS system have fail-safe measures. For example, with the electro/hydraulic setup, the system automatically counteracts possible causes of failure, both electronic and hydraulic, converts the entire steering system to a conventional two-wheel steering type. Specifically, if a hydraulic defect should reduce pressure level (by a movement malfunction or a broken driving belt), the rear-wheel-steering mechanism is automatically locked in a neutral position, activating a low-level warning light.

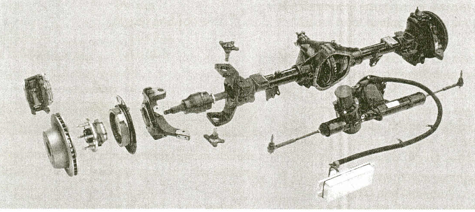
An electrical failure would be detected by a self diagnostic circuit in the four-wheel- steering control unit. The control unit stimulates a solenoid valve, which neutralizes hydraulic pressure, thereby alternating the system to two-wheel steering. The failure would be indicated by the system’s warning light in the main instrument display.

On any 4WS system there must be near-perfect compliances between the position of the steering wheel, the position of the front wheels, and the position of the rear wheels. It is usually recommended that the car be driven about 20 feet (6 meters) in dead-straight line. Then, the position of the front/rear wheels is checked with respect to the steering wheel position. The base reference point is a strip of masking tape on the steering wheel hub and the steering column. When the wheel is positioned dead center, draw a line down the tape. Run the car a short a distance straight ahead to see if the reference line holds. If not, corrections are needed, such as repositioning the steering wheels.

Even severe imbalance of rear wheel on a speed-sensitive 4WS system can cause problems and make basic troubleshooting a bit frustrating.

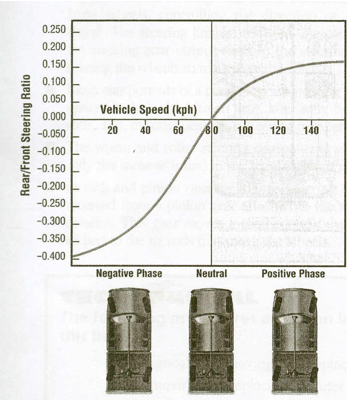
**Quadrasteer**

Quadrasteer is a 4WS system that improves low –speed maneuverability (decreasing the turning radius), high-speed stability, and trailering capabilities for full-size pickups, vans, SUVs. The system combines normal front-wheel steering with an electrically controlled rear-wheel steering system. Besides the mechanical part, the system uses wheel position and vehicle speed sensors and a central control module **(Figure 44 – 39).**

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**Figure 44-39** An exploded view of the Quadrasteer setup.

At low speed, the rear wheels turn in the opposite direction of the front wheels **(Figure 44 – 40).** At moderate speeds, the rear wheels remain straight. At high speeds, the rear wheels remain straight. If the system were to fail, the truck would default to normal two-wheel steering.

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**Figure 44-40** The different operational modes of a Quadrasteer system.

| **Operation Sheet**  **No. 1** | **Unit** | **Service Manual Steering System** |
| --- | --- | --- |
| **Module** | **Servicing Manual Steering System** |

**LO1: Analyze front end geometry failure**

**LO2: Service steering system**

**PROCEDURE**

**Rack and Pinion Steering Inspection**

STEP 1 *Check all working component* ***(Figure44 – 33)*** *of the system. Inspects the flexible steering coupling or the universal joints for wear or looseness. If any play is found, recommend replacements. Universal joints can also seize or bind. They should be checked closely.*

STEP 2 *Grasp the pinion gear shaft at the flexible steering coupling and try to move it in and out the gear. If there is movement, the pinion bearing preload might need adjustment. If there is no adjustment, internal components have to be replaced.*

STEPS 3 *Carefully inspect the rack housing. In most cases, the rack and pinion steering assemblies, the rack and pinion steering are mounted in rubber bushings. As the vehicle gets older, these mounting bushings deteriorate from the heat, age, and oil leakage from the engine. When this happens, the housing moves within its mountings and causes loose and eratic steering can be caused by a bent rack assembly, tight yoke bearing adjustment, loose power-steering belt, weak pump, internal leaks in power-steering belt, weak pump,, internal leaks in power-steering system, and damaged CV Joints from-wheel-drive vehicles.*

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